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(54) A METHOD OF PRODUCING A SCREEN IN THE FORM OF AN ENDLESS BAND AND APPARATUS FOR PERFORMING THE SAME

(71) I, MANFRED SCHOELLER, a German Citizen of 12 Leopoldstrasse, Duren-Rheinland, Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a method of producing screens in the form of endless bands, particularly for draining the water from the paper stock in paper-making machines, said screens consisting of a layered mesh or net formed by the superimposition of at least two layers of parallel filaments in which the filaments of each layer cross the filaments of the contiguous layer, and which are bonded together at least at some of their intersections. A layered mesh of such a kind is already known in the art. It is used for instance for making carrier bags and for applications in which the concise preservation of shape is unimportant. Consequently no particular care need be taken in the production of the conventional type of layered mesh to ensure that the mesh possesses a high degree of resistance to deformation. Screens which are intended for dewatering the paper stock in a paper-making machine, and which are constructed of a layered mesh of the above specified kind, have already been described in British Patent Specification No. 1,053,954. The mesh according to this British Patent Specification is made of filaments of synthetic material. However, tests have established that the layered mesh according to this British Patent Specification likewise easily pulls out of shape. More particularly, it lacks sufficient transverse rigidity, a property which in the above-mentioned tests on paper-making machines has proved to be of considerable importance, particularly in the case of screens of major width. Moreover, the above-mentioned British Patent Specification does not state how such layered mesh screens are to be produced. It has also been proposed in British Patent Specification 31,024/68 (Serial No. 1,224,629) so to contrive screens for draining the water from the paper stock in paper-making machines in the form of several crossing layers of filaments that the screens will possess the required deformation resistance and particularly the necessary transverse rigidity, even when the filaments consist of a synthetic material.

In principle the above-mentioned tests have shown that layered mesh screens have certain advantages over screens consisting of a conventional interwoven mesh. More particularly, in a layered mesh screen the ratio of the open area of the mesh to the diameter of the filaments can be varied within much wider limits than in a woven mesh. This means that in a layered mesh there is much greater latitude than in a woven mesh for independently choosing the required mechanical strength of the screen, its web-forming properties, its perviousness, and its ability to be kept in lateral alignment, without the necessity of having to accept a narrow and inflexible compromise. Moreover, layered mesh screens can be more easily made endless than woven screens, particularly when these consist of synthetic materials. Furthermore, it is readily possible to impart to a layered mesh a specific bonding strength by selecting the strength of the individual bonds at the cross-over points of the filaments of consecutive layers. A specifically selected strength of these bonds also contributes towards the ease with which such a screen can be kept in lateral register. In a woven mesh screen the strength of the bonds between the filaments cannot be independently selected, because in such screens the gauge of the filament, the shape of the mesh and the strength of the bond are

inter-dependent and necessitate accepting a compromise.

The object of the present invention is the provision of a method or of several methods and/or modifications of methods as well as of apparatus for performing these methods and/or their modified forms which, without involving major technical means, permit screens consisting of a layered mesh comprising at least two layers, particularly screens of the above-specified kind, to be reliably produced in the form of endless bands in such a way that according to requirements they will possess the desired properties, particularly the above-described properties, individually or in combination. Moreover, another object of the invention is to provide convenient arrangements and developments that will be hereinafter described with a view to securing specific advantages.

For solving this problem and for attaining these objects the invention provides a method of producing a screen in the form of an endless band comprising a mesh or net formed by the superimposition of at least two layers of parallel filaments in which the filaments of each layer cross the filaments of contiguous layer(s), and in which the filaments are bonded together at at least at some of their intersections; comprising the steps of firstly depositing the filaments which are to form the first layer on a supporting backing surface in side-by-side and spaced relationship and temporarily bonding said filaments to said backing surface to form a self-supporting sheet, and subsequently depositing the filaments which are to form the second directly superimposed layer on said sheet in the relative positions they are to occupy on the filaments of the first layer in the completed mesh, bonding the filaments of the two layers together at at least at some of their intersections, applying, if necessary, one or more subsequent layers in a manner analogous to the depositing and bonding of the second layer and removing said backing when at least two layers have been interconnected.

One or more further layer(s) of filaments may be superimposed and bonded to form a further one or more layers on the said first and second layers.

The step of assembling the filaments intended to form a first layer side-by-side and at the intervals they are to have in the completed mesh on a supporting backing surface results in the formation of a stable supporting surface upon which the filaments of a second contiguous layer can be superimposed. A firm supporting surface is thus provided for the reception of the filaments of the second contiguous layer and by bonding the two sets of filaments at least at some of their intersections a layered mesh comprising two layers is formed which is and remains cohesively united even after the backing surface is removed. The backing surface also affords the considerable advantage of permitting the layered mesh to be produced to extremely precise dimensional tolerations, a feature which is of special importance when such a mesh is to be used as a filter. A suitable material for the filaments is primarily metal or a synthetic material. The filaments may therefore be wires, monofils or multifils. The bond at the points of intersection may in principle be created by welding, by means of an adhesive, or in the case of metals, by soldering. The process which is continuously and/or intermittently performed in consecutive sections is in principle capable of being incorporated in a continuous production process. The direction of the filaments in each layer may differ according to existing conditions. However, generally speaking it may be assumed that the filaments in one layer will preferably be parallel and equidistantly spaced. The question of preferred directions of filament disposition will be later discussed. The layered mesh, which is first built up from two layers, may then be adjusted and/or cut to the size the contemplated screen is to possess. When this is being done the backing surface may already have been removed. However, it is quite feasible not to remove the backing surface until afterwards. The two-layer mesh may already be the finished mesh which may merely have to be made endless by joining the ends. However, further layers of filaments can now be applied if the required layered mesh is to possess say three or four or more superimposed layers. When further layers of filaments are applied and bonded, the two-layer mesh will provide a self-supporting base, even if the backing surface has already been removed, for the application of further filament layers. The layered mesh need not be made endless by joining the ends until all the layers of filaments have been superimposed and bonded together.

The method according to the present invention particularly comprises forming a sheet-like assembly by depositing the filaments that are to form the first layer onto a backing (for instance of paper), adhesively, by embedment or the like. The backing may then be removed when at least one further layer of filaments has been deposited on and bonded to the first layer.

For adhesively attaching the filaments to a backing the adhesive may be applied to the backing or to the filaments or to both.

Quite generally speaking a convenient method of producing a layered mesh according to the invention may compose aligning the filaments of one of two directly contiguous layers of crossing filaments in the lengthwise direction of the band (to form longitudinal filaments) and the filaments of

the other layer in the widthwise direction (to form transverse filaments).

The longitudinal filaments of at least one layer in the finished screen serve for taking up the longitudinal tension in the screen. At the same time they maintain the transverse filaments correctly spaced. The transverse filaments substantially determine transverse rigidity and, to the extent they form the uppermost layer in a screen for a paper-making machine, they also decide the web-forming and draining properties the screen will possess.

The following steps of the method according to the invention relate to the manner in which a sheet-like assembly comprising longitudinal filaments may be produced.

The sheet-like assembly used in the method of the invention may comprise longitudinal filaments that have unconnected ends or that are endless by virtue of their ends having been joined together or that are endless by virtue of the manner of their application.

In order to produce an endless screen the layered mesh must be made endless unless it is constructed of endless layers or of filaments that have been applied in endless lengths. However, in principle, the sheet-like assembly can be produced in either of the three variants hereinbefore described.

In one alternative for producing a sheet-like assembly from filaments having at least initially unconnected ends, the backing (such as paper) has the form of a continuously moving endless or finite length band, possibly of the same width as the full width of the intended screen. A sinite band would be drawn off a supply roll. In synchronism with the moving band a preferably appropraite number of filaments to cover a width equal to that of the backing is drawn off a creel. These filaments are conducted in side-by-side disposition (forming a band) through an applicator which may at the same time provide the filaments with an adhesive, and which attaches the filaments to the synchronously travelling backing surface.

A sheet-like assembly thus produced can be subsequently made endless, but it will then have a join in it.

In a second alternative, an endless sheet-like assembly is produced, longitudinal filaments being wound helically on a revolving backing which may have the form of a cylinder or preferably, of an endless travelling band.

Longitudinal filaments that have been thus laid will directly form an endless layer of filaments lacking a join.

A useful development of the second alternative consists in performing the helical winding process by simultaneously winding at least two and preferably about 20 or more filaments that are withdrawn continuously from a creel and conducted through an applicator moving across the direction of travel of the backing, said applicator possibly at the same time applying adhesive to the filaments and depositing the band of filaments in side-by-side longitudinal convolutions on the backing.

This procedure likewise creates an endless layer of filaments without a join. It is a method which by simultaneously applying a large number of filaments is extremely economical to perform.

The steps that will now be described relate to the production of a sheet-like assembly of transverse filaments.

In one such method of producing a sheet-like assembly of transverse filaments the latter are despoited on a backing, in the form of a cylinder or preferably in the form of a band (which may be endless) running under tension over cylinders, in a direction across the periphery of the cylinder or across the longitudinal direction of the band.

In a suitable development of this method at least two and preferably about twenty or more filaments are simultaneously applied and conducted in side-by-side disposition in a form resembling a band (filament band) through an applicator which is traversed across the peripheral or longitudinal direction of the backing, and which may at the same time provide the filaments with an adhesive. At the end of each applicator traverse the backing is advanced in the peripheral or longitudinal direction by the width of the band of applied filaments.

By simultaneously applying a suitably large number of transverse filaments this operation can likewise be very economically performed. However, the method requires the provision of a special apparatus, besides the apparatus that is needed in any event for forming the sheet-like assembly of longitudinal filaments.

However, this additional apparatus can be dispensed with if the following procedure is adapted. This comprises producing a sheet-like assembly of transverse filaments by first producing a sheet-like assembly of longitudinal filaments by one of the said two alternative methods hereinbefore described for this purpose, cutting this sheet-like assembly across its peripheral or longitudinal direction into individual lengths each roughly equal to the width of the contemplated screen, turning the cut lengths until the filaments contained therein align with the crosswise direction, connecting the cut lengths together preferably by adhesively joining them on their undersides and thus forming a preferably endless band.

This procedure has the advantage that the only apparatus that is needed is that which is required for forming the sheet-like assembly

of longitudinal filaments. When the assembly of longitudinal filaments is to be thus transformed into a sheet-like assembly of transverse filaments the best method of producing the initial sheet-like assembly of longitudinal filaments would be that is which the backing is withdrawn continuously from a supply roll and the filaments are applied to the backing as they travel in the same direction as the backing at a synchronous speed. The resultant sheet-like assembly can then be easily cut into lengths during the synchronous travel of backing and filaments and the entire process can be performed in a continuous operation.

In a development of the above method the (initially) longitudinal edges of the cut lengths, before these are joined together, may be so trimmed that the trimmed edges will not project beyond the last filament at the edge by more than half the clear spacing of the other filaments.

This will ensure that at the joints between the cut lengths, when these have been reconstituted in the form of a band, the spacing of the new transverse filaments will be completely uniform.

In a convenient procedure the edges may be trimmed before the initial sheet-like assembly is cut into lengths.

Moreover, a useful way of cutting the initial sheet-like assembly into lengths consists in cutting approximately perpendicularly across the direction in which the filaments lie.

When the assembly of longitudinal filaments has been formed by helical winding onto a revolving backing as hereinbefore described, this direction slightly differs from the peripheral or longitudinal direction of the initial sheet-like assembly. Another preferred step comprises joining the edges of the cut and turned lengths that the filaments at the joints are spaced the same distance apart as the other filaments in the assembly.

The procedural steps and variants of the method according to the invention as hereinafter described relate to the production of the finished screen in the form of a layered mesh comprising at least two superimposed layers of filaments from a sheet-like assembly produced as hereinbefore described.

In principle, the production of a screen in the form of a layered mesh comprising at least two layers of superimposed filaments proceeds by producing a sheet-like assembly in the form of an endless band of the proposed width and length of the contemplated screen by performing the above-described steps for the production of (a) sheet-like assemblies of longitudinal filaments, (b) sheet-like assemblies of transverse filaments that have been directly thus laid, or (c) of sheet-like assemblies of transverse filaments obtained by turning and rejoining lengths cut from assemblies of longitudinal filaments, and by then applying further layers of filaments to these sheet-like assemblies, bonding the filaments and finally removing the locating means of the sheet-like assemblies.

This procedure may comprise applying the further layers of filaments before their ends are joined or, if intended for taking up tensile loads, after they have been made endless by their ends having been joined, or in a form in which they are endless by virtue of the manner of their application.

One way of carrying this process into effect consists in directly applying further layers of filaments to that side of the sheet-like assembly on which the first layer of filaments is located.

Another way consists in that at least one of the additional layers of filaments is itself located by having been transformed into a sheet-like assembly of filaments which may be turned over before application so that the transverse filaments which are first on top of the band are, when the assembly is applied to the layer containing longitudinal filaments directly in contact with the longitudinal filaments.

In another procedure any one or more backing surfaces that would otherwise prevent filament-to-filament contact may be removed before the final layers of filaments are applied.

In principle the performance of all these steps may include joining the ends of at least one layer of longitudinal filaments unless at least one layer of endless longitudinal filaments is or has already been applied in a manner that requires no joining.

Particular variants for producing a jointless screen are hereinafter described.

In a first variant for producing a jointless screen comprising one layer of transverse filaments and a superimposed layer of longitudinal filaments, a sheet-like assembly of transverse filaments is produced by one of the above-described methods, either by the direct application of transverse filaments or by turning and rejoining cut lengths of an assembly of longitudinal filaments. The sheet-like assembly of transverse filaments is then conducted over cylinders and then a layer of longitudinal filaments is applied, preferably by the process of helical winding hereinbefore already described for the production of sheet-like assemblies of longitudinal filaments.

In a second variant of producing a jointless screen comprising one layer of longitudinal filaments and a superimposed layer of transverse filaments, a sheet-like assembly comprising longitudinal filaments is first produced by one of the above-described methods and a layer of transverse filaments is then applied thereto by one of the

above-described methods of producing sheet-like assemblies of transverse filaments.

In a further variant of producing a jointless screen wherein one layer of longitudinal filaments is sandwiched between two layers of transverse filaments, a two-layer mesh comprising one layer of transverse filaments and a superimposed layer of longitudinal filaments is first produced as in the hereinbefore described first variant and transverse filaments are then applied thereto by one of the previously described methods of producing sheet-like assemblies of transverse filaments.

In a first modification of this latter procedure the transverse filaments that are applied last are likewise first transformed into a sheet-like assembly of transverse filaments according to one of the above-described methods of producing sheet-like assemblies by the direct application of transverse filaments or by rejoining the turned cut lengths of sheet-like assemblies of longitudinal filaments, the sheet-like assembly of transverse filaments being then turned upside down and deposited upside-down on the layer of longitudinal filaments of the two-layer mesh, the contacting longitudinal and transverse filaments being bonded together and the two backings removed.

In this latter procedure the last applied sheet-like assembly may be submitted to a shrinking process.

According to a second modification the sheet-like assembly which is to be applied last is superimposed in the form of a (possibly cut) band of finite length slightly shorter than the circumferential length of the two-layer mesh, thereby to leave a narrow gap (in the crosswise direction) where the ends of the assembly after application abut, and subsequently a band of filaments of appropriate width is inserted into this gap, possibly in a manner analogous to the above-described method of producing sheet-like assemblies of directly applied transverse filaments.

Alternatively, for producing a jointless screen comprising one layer of transverse filaments sandwiched between two layers of longitudinal filaments a two-layer mesh is produced from one layer of longitudinal filaments and a superimposed layer of transverse filaments by the second variant and longitudinal filaments are then applied thereto, preferably by helical winding, analogously to the above-described method of producing sheet-like assemblies of longitudinal filaments.

A modification of this latter procedure is characterised in that instead of first producing the two-layer mesh according to the second variant a two-layer mesh comprising one layer of transverse filaments and a superimposed layer of longitudinal filaments is first produced according to the first variant and this mesh is turned over before being further processed.

The variants hereinbefore described are comprised in a general method which is characterised in that for the production of a jointless screen comprising any number of layers consisting alternately of transverse and longitudinal filaments, the steps in the first and second variants hereinbefore described are performed in combination with a repetition of the steps described in the following particular methods.

By experiment it has been established that it is particularly advantageous to bond the filaments of two directly contiguous layers at the points of intersection by means of an adhesive. It has also been confirmed by tests that the use of adhesives is also desirable in the production of the sheet-like assemblies. The advantage of adhesives resides more particularly in that adhesives of different compositions can be chosen which, irrespectively of the nature of the filaments, the supporting surface or backing etc., are the best to use for the particular purpose in view.

Based on this consideration the proposed methods and/or their alternatives and modifications in the hereinbefore described variants may generally further comprise forming a sheet-like assembly by establishing the bond between the filaments of a layer and the above-described backing by means of an adhesive or a component of a multi-component adhesive or a combination of adhesives. This adhesive is so chosen that it can be removed by dissolving the same with a solvent which may also dissolve the backing without attacking the filaments of the layers themselves. The bond between the filaments of the layers at their points of intersection is established by a different adhesive or multi-component adhesive system which (possible after an intermediate treatment, for instance by the application of heat) is not soluble in the solvent.

In a first particular application of this bonding method, for bonding the filaments of a layer to the supporting surface of a backing the latter should be coated with a rubber-based adhesive soluble in a solvent, for example benzine (e.g. natural rubber, regenerated rubber, styrene-butadiene rubber). The filaments of the layers, which preferably consist of benzine-insoluble polyester monofils (polyester terephthalates), should be provided with a coating of a benzine-insoluble polyurethane-based adhesive (particularly an isocyanate - modified polyester/polyisocyanate cross-linking adhesive). The filaments of the layers, possibly after having been conducted through a heating means, should then be applied, preferably by an

applicator as hereinafter described, to the backing to form a contact bond.

In a second particular application of this method which relates to directly adhesively bonding the filaments of a second layer to the filaments of a contiguous first layer which already forms part of a sheet-like assembly or of a layered mesh comprising at least two layers of filaments, the filaments of the second layer, which are preferably benzine-insoluble polyester monofils (polyester terephthalates) are provided with a coating of a benzine-insoluble highly viscous adhesive based on polyurethane (such as polyisocyanate-modified polyester/polyisocyanate cross-linking adhesives) and then immediately applied to the filaments of the first layer before the adhesive has dried or set.

The said second particualr application may comprise coating the filaments of the second layer by conveying them through a chamber associated with an applicator, said chamber containing the highly viscous adhesive, and then passing the filaments through the applicator constituted by a comb which by virtue of its narrow gap widths provides the top and bottom of the filaments with a cap of adhesive (elliptical coating) in which the filaments at the points of intersection become deeply embedded when they make contact.

In a third particualr application for adhesively bonding a second layer of filaments which have already been located (i.e. formed into a sheet-like assembly or incorporated in an at least two-layer mesh) to a directly contiguous first layer of filaments which are likewise already located (formed into a sheet-like assembly or a layered mesh comprising at least two layers), the second layer of filaments is deposited on the first layer of filaments so that the filaments make contact at the points of intersection, and they are bonded together at these points by hot sealing, which comprises heating the contact points for reactivating the adhesive coating on the filaments and pressing the filaments together, for instance by means of a heated pressure roller.

The above-described particular applications of the methods which relate to the bonding of the filaments have the following advantages. As has already been mentioned, the specified rubber-based adhesives are readily soluble in benzine, whereas the specified adhesives based on polyurethane are extremely resistant to benzine. The backings can therefore be readily detached by using benzine as a solvent and the fine mesh of crossing filaments will not be damaged thereby. The bonding strength of the said polyurethane-based adhesives on filaments preferentially used for the mesh, preferably polyester monofils (polyester terephthalates), is very good. Moreover, the said polyurethane-based adhesives have been found to adhere well upon contact with rubber-based adhesives with which, as hereinbefore described, the backing surfaces are coated before the filaments are applied thereto. Furthermore, polyurethane-based adhesives have the advantage that they are capable of forming a hot-sealing bond. They are therefore also suitable for use in the last of the above-described methods of bonding.

Polyurethane-based adhesives have yet another advantage in connection with the above-mentioned bonding strength which should preferably have a particular value, because they permit the strength of the bonds at the intersections between the filaments to be made more or less rigid, thereby facilitating keeping the screen in lateral register. Polyurethane-based adhesives are two-component systems, and by suitably selecting the mixture proportions of the components and thereby controlling the resultant degree of cross-linking the elasticity of the bond after the bond has set, can be varied within a range best adapted to the requirements of the mesh.

The inventive features of the above-mentioned apparatus for performing the method and/or variants of the method according to the invention principally concern the construction of the previously mentioned applicators.

The said applicators serve for dimensionally correctly co-ordinating and applying the filaments or band of filaments to a supporting surface. This supporting surface may be constituted by a band-like assembly of filaments resting on the backing, or the previously mentioned sheet-like assemblies and/or the repeatedly mentioned layered mesh comprising an as yet incomplete number of superimposed layers of filaments.

One embodiment of the said applicator consists of a comb having gaps between teeth facing the supporting surface and a following press-on bar (preferably made of polytetrafluoroethylene) for pressing the filaments on the supporting surface directly behind the comb.

The adhesion of a press-on bar of polytetrafluoroethylene is slight, the rubbing friction of the filaments on such a bar is low and the co-ordinated arrangement of the filaments is not thereby disturbed. This type of applicator is principally intended for applying filaments that have already been coated with a polyurethane adhesive and passed through a drying section so that the filaments are prepared for bonding on contact.

A first modification of the said applicator comprises a grooved roller (preferably made of polytetrafluoroethylene) of which the side facing the supporting surface serves to guide the filaments and to press the same on the

supporting surface and a preceding comb which operates to feed the filaments of the band of filaments to the grooved roller in the desired relative arrangement.

This modification of the applicator has the same advantages in principle as the first above-described applicator and is used with the same advantage as the former.

A second modification of the said applicator comprises a comb having gaps between teeth facing a backing for guiding the filaments, a preceding container which is closed on the exit side of the filaments by said comb, and which serves for the reception of the above-mentioned highly viscous adhesive and guide means for guiding the backing and the filaments over an arched surface following the comb, so contrived that the adhesive-coated filaments automatically run on the backing and bond to the same immediately after having run through the comb.

This type of applicator is intended for applying filaments provided with an adhesive coating that has not yet dried and solidified, as described in connection with the said second particular application of the method of adhesive bonding. The gaps in the comb of this applicator incidently also serve for controlling and shaping the adhesive coatings on the issuing filaments (elliptical coatings). A press-on bar is not required in this type of applicator. The filaments are automatically pulled tangentially onto the backing by the curvature of the surface underneath.

The proposed arrangement also comprises means for controlling and guiding the applicator across the direction of travel of the filaments that are to be applied, particularly for performing the above-described procedures in which the band of filaments is repeatedly applied to a backing in side-by-side disposition. It is preferred that the said controlling and guiding means as adapted to control and guide the marginal filaments of two neighbouring bands of filaments so that when laid they are spaced the same distance apart as the filaments within the band. According to the invention such an arrangement may comprise a sensor in the form of a comb which has teeth facing the backing, a grooved cylinder or the like, for engaging the troughs between the filaments that have already been affixed to the backing, and which through a transmission affects means controlling the traverse of the applicator, or which, in the case of filaments of a gauge that is not too fine, is mechanically directly coupled to the applicator.

The drawings illustrate embodiments of apparatus, modifications and parts thereof, for performing selected methods and variants thereof according to the invention, as well as embodiments of products thereby produced, partly represented in different stages of production. The following description also further clarifies and explains the general nature of the invention by reference to these drawings.

The Figures of the drawings are schematic and not true to scale. Different scales of representation are also occasionally used in one and the same drawing. In the drawings:

Fig. 1 is a longitudinal section of a working applicator comprising a comb having teeth facing a supporting surface associated with a container for the reception of a highly viscous adhesive, the drawing also showing the curved supporting surface;

Fig. 2 is a perspective representation of the method of helical winding for the application of a band of longitudinal filaments to a backing in the production of a sheet-like assembly, or to an existing sheet-like assembly and/or to a multi-layer mesh consisting of an incomplete number of layers, the applicator being controlled and guided by a sensor;

Fig. 3 is a perspective representation of the application of bands of filaments side-by-side to a backing for the production of a sheet-like assembly or to an existing sheet-like assembly and/or a multi-layer mesh consisting of an as yet incomplete number of layers;

Fig. 4 is a side elevational view of a complete apparatus, arrangement or paint for the production of sheet-like assemblies of transverse filaments obtained by joining together turned lengths of sheet-like assemblies of longitudinal filaments, a backing being withdrawn from a supply roll and a plurality of longitudinal filaments corresponding to the width of the backing being withdrawn from a creel;

Figs. 5 to 8 are fragmentary cross sections, on an enlarged scale, of sheet-like assemblies in which different methods of bonding have been employed for attaching the filaments to a backing, Fig. 5 being a wet bond established by means of a binder on the filaments, Fig. 6 a contact bond using a polyurethane-based binder on the filaments and a rubber-based binder on the backing, Fig. 7 being a holding bond (not drying) using a binder on the backing and Fig. 8 a bond by embedment in a binder having a high solids content;

Fig. 9 is a perspective representation of the method of bonding a sheet-like assembly of one layer of filaments by hot sealing to another sheet-like assembly of another layer of filaments or to a layered mesh comprising at least two layers of filaments;

Figs. 10 and 11 are sections on a larger scale taken on the lines X-X; XI-XI in Fig. 9, and

Figs. 12 and 13 are sections on the same scale as in Figs. 10 and 11, illustrating two stages in the further procedure of forming a

layered mesh of four superimposed layers of filaments.

Referring to Figure 1 the applicator illustrated in this Figure is fitted with a comb 19 formed with teeth pointing towards a backing surface 18, the comb guiding the filaments 20. A container 21 precedes the comb 19 and contains a highly viscous adhesive. The backing 18 and the filaments 20 immediately after leaving the comb 19 run over a convexly arched surface 22 which permits the filaments 20 that have been coated with adhesive to ride onto the backing 18 and to adhere thereto. The arched surface 22 may preferably rotate in the direction indicated by the arrow 23. The filaments 20 arrive in the direction of the arrow 24, whereas the backing 18 feeds in the direction of the arrow 25. The backing 18 may be the surface of a carrier which together with the filaments 20 deposited thereon will then form a sheet-like assembly. The backing 18 may itself be a sheet-like material and the filaments 20 will then form a layer of filaments on the backing. Moreover, the backing may itself be a layered mesh containing at least two layers of superimposed filaments, in which case the filaments 20 will form an additional layer of filaments. The entry of the filaments 20 into the container 21 is preferably provided with soft flexible sealing means 26. The gaps between the teeth of the comb 19 not only guide the filaments 20, but also control the rate of application and the shape of the coating of adhesive on the filaments as they leave the container. The adhesive may be continuously supplied as indicated by an arrow 27.

Referring now to Fig. 2, a band of longitudinal filaments 30 is deposited in helical windings on a backing 28 which revolves in the form of an endless band indicated by arrows 29. The filaments 30 are drawn off a creel 31 and they are first collected and assembled side-by-side by a comb 32. They then run to the applicator 33 which may conveniently be constructed as illustrated in Fig. 1. The applicator 33 is attached to a slide 35 which can be traversed on a railway 36. The applicator 33 traverses in the direction of the arrow 34. When the band of filaments 30 is applied it is desirable that the filaments on the edges of neighbouring bands should be spaced the same distance apart as neighbouring filaments within the band. This necessitates a very precise control of the traversing movement of the applicator 33. This precision must be the higher the finer the gauge of the filaments 30. For precisely controlling and guiding the applicator a sensor 37 in the form of a comb with teeth facing the carrier or of a grooved roller or the like is provided. This sensor engages the troughs between neighbouring filaments already affixed to the carrier and its position is controlled by the position of these troughs. The sensor movements affect a controller mechanism not shown which in turn controls an effector mechanism not shown for guiding the applicator 33. If the gauge of the filaments is not too fine the sensor 37 may guide the applicator 33 by a direct mechanical linkage. The backing 28 may be a carrier and the helical winding of the filaments gives rise to the formation of a seamless sheet-like assembly comprising longitudinal filaments. The backing 28 may itself be a sheet-like assembly in the form of a carrier and transverse filaments. In such a case the helical winding operation gives rise to the creation of an endless two-layer superimposed filament mesh without a join.

In the embodiment illustrated in Fig. 3, an endless backing 38 revolves in the direction indicated by an arrow 39. This backing 38 may likewise be a carrier or a sheet-like assembly formed by a carrier already provided with longitudinal filaments. Transverse filaments 40 are deposited thereon by an applicator 41. The transverse filaments 40 are withdrawn in the form of a band of parallel filaments from a supply bobbin 42. The applicator 41 and the bobbin 42 are mounted on a common slide 44 which can be reciprocated in the directions indicated by a double-headed arrow 43. As has already been mentioned the production of a sheet-like assembly comprising transverse filaments as shown in Fig. 12 is more complicated than the production of an assembly comprising transverse filaments obtained by turning sections bearing longitudinal filaments. This is due to the following reasons. The mode of operation in Fig. 3 is intermittent (to and fro). The comb of the applicator 41 and the band 40 of filaments must therefore be consecutively repositioned (at the edge of the travelling backing). Moreover, the band 40 of filaments must be specially wound on the supply bobbin 42, each individual filament having the same tension and alignment. Otherwise some of the filaments might be slack upon being unwound and they would then fail to bond as desired, the required orderly arrangement not being achieved. It is therefore preferred to proceed as will be described with reference to Fig. 4.

In the arrangement illustrated in Fig. 4 the filaments are withdrawn from a creel 46, pass through a comb 47 and are coated at 48 with an adhesive, preferably of a composition based on polyurethane. They then travel through a drying section 49 over deflecting combs 50 to an applicator 51, at the same time forming a band 52 of filaments. Simultaneously a carrier or backing surface 55, which may be paper, is withdrawn from a supply roll 53 in the direction of the arrow 54. A wiper (spreader blade) is provided at 56

for coating the carrier surface 55 with an adhesive preferably based on a rubber composition. The applicator 51 guides the band 52 of filaments and presses it on the carrier surface 55, thereby producing a sheet-like assembly 57 comprising longitudinal filaments. This is taken over a deflecting roller 58 in the direction of the arrow 59. After having run over the deflecting roller 58 the band 52 of filaments will be on the underside of the carrier 55. At 60 the edges of the sheet-like assembly are trimmed by roller cutters. At 61 the edge of the assembly is provided with an adhesive tape. 62 are drawing rollers which revolve as indicated by the arrows 63. 64 is a cutting shear. 65 is a working platform for the production of a sheet-like assembly comprising transverse filaments by turning the cut lengths until the direction of the filaments in each length coincides with the transverse direction and by then joining the cut lengths in this fresh position together to form a preferably continuous band by sticking together the adhesive tapes that had been applied at 61. The method performed by means of the apparatus in Fig. 4 has the advantage that the same apparatus can be used substantially without modification for the production of sheet-like assemblies with longitudinal filaments or of sheet-like assemblies with transverse filaments. When sheet-like assemblies with longitudinal filaments are thus produced, the width of the band 52 of filaments can be chosen to coincide with the width of the required screen. When producing sheet-like assemblies with transverse filaments from turned lengths of assemblies with longitudinal filaments, the width of the band 52 of filaments can be chosen by reference to other requirements. The lengths that are cut off by the shear 64 should, however, generally correspond to the desired width of the screen. If the combination of adhesives used is that of an adhesive based on polyurethane with an adhesive based on rubber, the filaments of the band 52 will preferably be polyester monofils.

Referring now to Figs. 5 to 8 a sheet-like web or assembly comprising a carrier or backing surface 66 provided with filaments 67 bonded thereto with a binder 68 is shown in Fig. 5. The binder 68 may be applied wet (for instance in the form of a dextrin binder) to the filaments 67, in which case it will collect in the wedge angles, as shown in the drawing, when the filaments 67 are pressed down on the carrier 66. The binder can be removed for instance by dissolving it out with water as soon as at least one second layer of filaments has been superimposed and a mesh comprising at least two superimposed layers has been formed. Fig. 6 exemplifies a bond produced with a contact adhesive. The filaments 67 have been provided with a coating 69 of an adhesive based on polyurethane. The carrier surface 66 has been coated with a binder 70 based on rubber. Contact adhesion has the advantage that the filaments 67 stick immediately they are pressed on the carrier 66 and that they need not be conveyed through a drying section. The subsequent passage through a drying section introduces an uncertainty factor into the accurate location of the filaments. Incidentally, the rubber binder 70 can be easily dissolved with benzine and the carrier 66 can therefore be later easily peeled off. The polyurethane-based adhesive 69 has the additional advantage of providing immediate adhesion when further layers of filaments are applied, a circumstance which assists extreme accuracy of location. By setting this adhesive the filament-to-filament bond at the points of intersection can be made permanent. Other advantages have already been mentioned above. Fig. 7 illustrates a holding adhesive bond. The binder 71 is applied to the carrier surface 66 and the filaments 67 are merely pressed on the surface. The holding adhesive 71 does not dry. An advantage is the simplicity of application of the filaments 67. However, for bonding these to further layers of filaments they must first be treated with special binders. Fig. 8 is an illustrative example of embedment during the production of a sheet assembly. For embedment an adhesive 72 having a high solids content is preferably used.

Referring now to Fig. 9, this shows a sheet assembly 76 containing one layer of filaments or a layered filament mesh comprising at least two superimposed layers permanently bonded together at the intersections. A further layer of filaments is to be provided which is itself already in the form of a sheet assembly 77, 77′. The sheet assembly or layered mesh 76 runs over rollers 78 in the direction indicated by an arrow 79. The sheet assembly 77, 77′ is drawn off a supply roll 80 and applied to the sheet assembly or layered mesh 76 by a hot press-on roller 81. It will be seen in Fig. 20 that a length of the sheet assembly 77, 77′ has already emerged on the left hand side of the roller 81. The bond between the sheet assembly or layered mesh 76 and the sheet assembly 77, 77′ in this instance is a hot sealing structural bond. For this purpose the filaments of the layers that are to be bonded at the points of intersection may have already been coated with a hot sealing adhesive, for instance of the polyurethane type.

The following description relates to Figs. 10 to 13.

The next Fig. 10 shows the product obtained with the apparatus in Fig. 9, 76 indicating a sheet assembly with transverse filaments. The sheet assembly 76 may consist

of a carrier backing surface 82 and transverse filaments 83. The sheet assembly 77 may comprise a carrier or backing surface 84 and longitudinal filaments 85. Fig. 10 shows the manner in which the transverse filaments 83 are bonded to the longitudinal filaments at the cross-over points (hot sealing bond). Fig. 11 is another product obtained by means of apparatus according to Fig. 9, on the assumption that 76 is a layered mesh comprising two superimposed layers of filaments from which the carrier or backing surface 86 has not yet been detached from the underside. The layered mesh 76 in Fig. 22 consists of transverse filaments 87 and longitudinal filaments 88. The sheet assembly 77′ comprises a carrier or backing surface 89 and transverse filaments 90. The hot sealing bond is formed in apparatus according to Fig. 20 between the transverse filaments 90 and the longitudinal filaments 88. Fig. 12 illustrates the product according to Fig. 11 after having been further processed. The carrier 89 has been detached and a fresh layer of longitudinal filaments 91 has been superimposed. For applying the longitudinal fialments 91 it is convenient to make use of the above-described method of directly applying a layer of filaments to a layer of filaments already provided. Preferably before their application the filaments 91 may be coated with a highly viscous polyurethane-based adhesive and with advantage they are applied by the applicator according to Fig. 1. Fig. 13 represents the final product, the carrier 86 having been likewise removed. The final product in the illustrated and described example is a layered mesh comprising four superimposed filament layers, of which two consist of longitudinal filaments (88, 91) and two are transverse filaments (87, 90). The production of a layered mesh comprising fewer or more layers proceeds in a manner analogous to that which has been described.

WHAT I CLAIM IS:—

1. A method of producing a screen in the form of an endless band comprising a mesh or net formed by the superimposition of at least two layers of parallel filaments in which the filaments of each layer cross the filaments of the contiguous layer or layers and in which filaments are bonded together at at least some of their intersections; comprising the steps of firstly depositing the filaments which are to form the first layer on a supporting backing surface in side-by-side and spaced relationship and temporarily bonding said filaments to said backing surface, to form a self-supporting sheet, and subsequently depositing the filaments which are to form the second directly superimposed layer on said sheet in the relative positions they are to occupy on the filaments of the first layer in the completed mesh, bonding the filaments of the two layers at at least some of their intersections, applying, if necessary, one or more subsequent layers in a manner analogous to the depositing and bonding of the second layer and removing said backing when at least two layers have been interconnected.

2. A method according to claim 1, in which the supporting backing surface is paper.

3. A method according to claim 1 or 2 in which the filaments forming the first layer are attached adhesively or by embedment to the backing surface.

4. A method according to any of Claims 1 to 3, in which for the production of a layered mesh in band form the filaments of one of two contiguous layers of crossing filaments are aligned with the lengthwise direction of the band thereby to form longitudinal filaments, and the filaments of the other of the said two contiguous layers are aligned with the cross-wise direction thereby to form transverse filaments.

5. A method according to any of Claims 1 to 4 in which comprising the formation of a sheet-like assembly of filaments, for the production of the sheet-like assembly, the said backing surface has the form of a continuously moving band which is endless, or of finite length drawn off a supply roll, and that in synchronism with the movement thereof filaments are drawn off a creel, said filaments being conducted in side-by-side disposition thereby forming a band through an applicator and subsequently being applied to the backing surface.

6. A method according to Claim 5, in which the said filaments drawn off a creel are sufficient in number to form a band of width equal to the width of the said backing surface.

7. A method according to Claim 5 or Claim 6, in which the said filaments are provided with an adhesive on the surfaces thereof during passage through the said applicator, by which the filaments are attached to the said backing surface.

8. A method according to Claim 4, comprising the formation of a jointless continuous sheet-like assembly of filaments in which for the production of the jointless continuous sheet-like assembly of filaments, longitudinal filaments are wound helically on a revolving backing surface in the form of an endless travelling band.

9. A method according to Claims 1 to 5, in which the said backing surface is in the form of an endless band.

10. A method according to Claim 9, in which the filaments are conducted in side-by-side disposition in a band through an applicator which is traversed across the peripheral or longitudinal direction of the backing surface, and in which at the end

of each traverse of the said applicator the backing surface is advanced across its peripheral or longitudinal direction of the backing by the width of the band formed by the applied filaments.

11. A method according to any of Claims 5 to 8, in which a sheet-like assembly comprising transverse filaments is produced by first producing a sheet-like assembly of longitudinal filaments and the said sheet-like assembly is cut across its peripheral or longitudinal direction into individual lengths and the thus cut lengths are turned so that the filaments contained therein are aligned in the cross-wise direction relative to the peripheral or longitudinal direction, and the cut lengths are then connected together to form a sheet-like assembly containing filaments lying transverse to its longitudinal direction.

12. A method according to Claim 11, in which the said cut lengths are joined on their undersides by adhesive.

13. A method according to Claim 11 or Claim 12, in which prior to turning and connecting the said cut lengths together, their initially longitudinal edges are trimmed so as not to project beyond the last filament at the edge by more than half the clear spacing of the other filaments.

14. A method according to any of Claims 11 to 13, in which the edges of the cut and turned lengths are so joined together that the filaments at the joints are spaced the same distance apart as the other filaments in the assembly.

15. A method according to any of Claims 5 to 14, in which the one or more subsequent layer(s) of filaments is/are applied directly to that side of the sheet-like assembly on which the first layer of filaments is located.

16. A method according to Claim 15, in which at least one of the said one or more subsequent layer(s) of filaments has already been transformed into a sheet-like assembly of filaments.

17. A method according to Claim 16, in which the sheet-like assembly is turned over before application to permit filament-to-filament contact of contiguous layers.

18. A method according to any of Claims 15 to 17, in which at least one layer of endless longitudinal filaments is applied.

19. A method according to any of Claims 15 to 17 for the production of a jointless screen comprising one layer of filaments transverse to the jointless screen and a superimposed layer of longitudinal filaments, in which the sheet-like assembly is produced from the said transverse filaments and conducted over cylinders and the longitudinal filaments are then applied thereto.

20. A method according to Claim 19, in which the longitudinal filaments are helically wound onto the sheet-like assembly.

21. A method according to any of Claims 15 to 18 or 20, in which the sheet-like assembly is first produced comprising filaments longitudinal to the jointless screen and transverse filaments are applied thereto.

22. A method for producing a jointless screen comprising one layer of longitudinal filaments sandwiched between two layers of transverse filaments, in which a two-layer mesh comprising one layer of transverse filaments and a superimposed layer of longitudinal filaments is first produced according to any of Claims 11 to 14 and transverse filaments are then applied thereto.

23. Modification of the method according to Claim 22, in which a sheet-like assembly is first formed according to Claim 9 or 10, from the transverse filaments that are to be applied last, the said sheet-like assembly is then turned over and the transverse filaments applied and bonded to the layer of longitudinal filaments of the two-layer mesh and that subsequently the two backing surfaces on the layers are removed.

24. A method according to Claim 23, in which the sheet-like assembly which is formed from the transverse filaments that are to be applied last is superimposed in the form of a band of finite length which is slightly shorter than the circumference of the two-layer mesh thereby to leave a narrow gap in the crosswise direction where the ends of the assembly after application abut, and that subsequently a band of filaments is inserted into the said gap.

25. A method according to any one of Claims 1 to 24, in which the filaments of the second layer are coated by being conveyed through a chamber associated with an applicator and containing a polyurethane adhesive, and the filaments then pass through the applicator constituted by a comb which by virtue of its narrow gap widths provides the top and bottom of the filaments with an elliptical coating of adhesive in which the filaments at the points of intersection are deeply embedded when they make contact.

26. A method according to Claim 23 for adhesively bonding a second layer of filaments which have already been formed into a sheet-like assembly or incorporated in an at least two-layer mesh to a directly contiguous first layer of filaments which are likewise already formed into a sheet-like assembly or a layered mesh comprising at least two layers, the second layer of filaments being deposited on the first layer of filaments so that the filaments make contact at the points of intersection and that they are bonded together at these points by a hot sealing process; in which the contact points for reactivating the adhesive coating on the filaments are heated and the filaments pressed together.

27. A method according to Claim 26, in

which the filaments are pressed together by a heated pressure roller.

28. A method of producing an endless screen as claimed in Claim 1, substantially as hereinbefore described.

29. A method of producing an endless screen, substantially as hereinbefore described and illustrated in any of the accompanying drawings.

30. An endless screen produced by a method as claimed in any of Claims 1 to 29.

31. A method as claimed in Claim 1 employing apparatus substantially as hereinbefore described and illustrated in any of Figures 1 to 4 or 9 of the accompanying drawings.

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1252745 COMPLETE SPECIFICATION

6 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

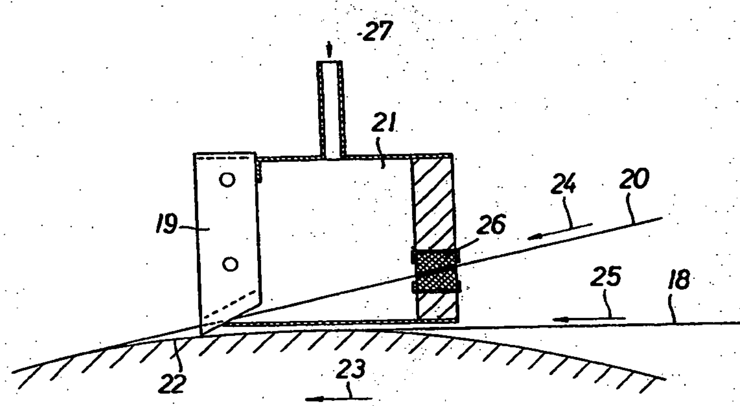

FIG. 1

1252745 COMPLETE SPECIFICATION

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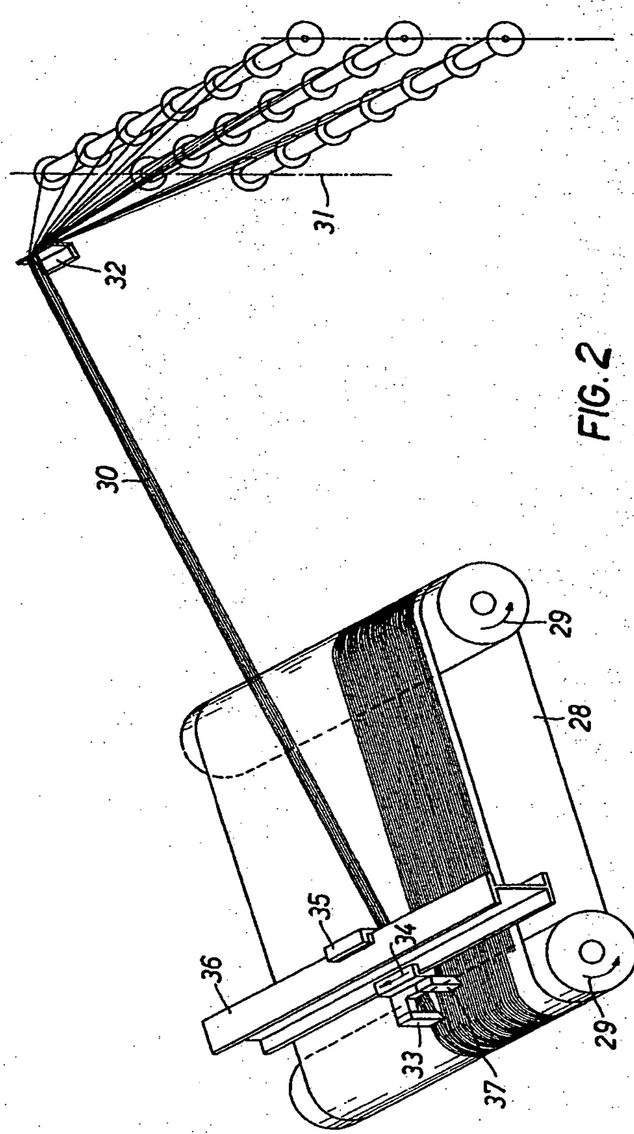

FIG. 2

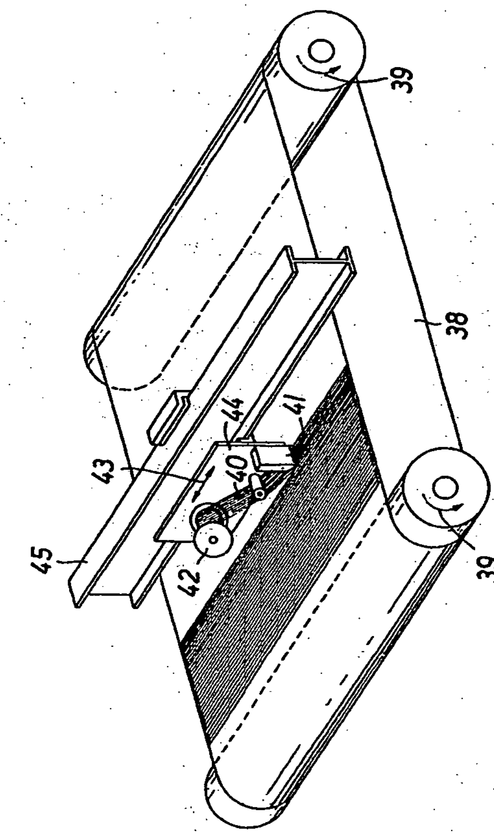

FIG. 3

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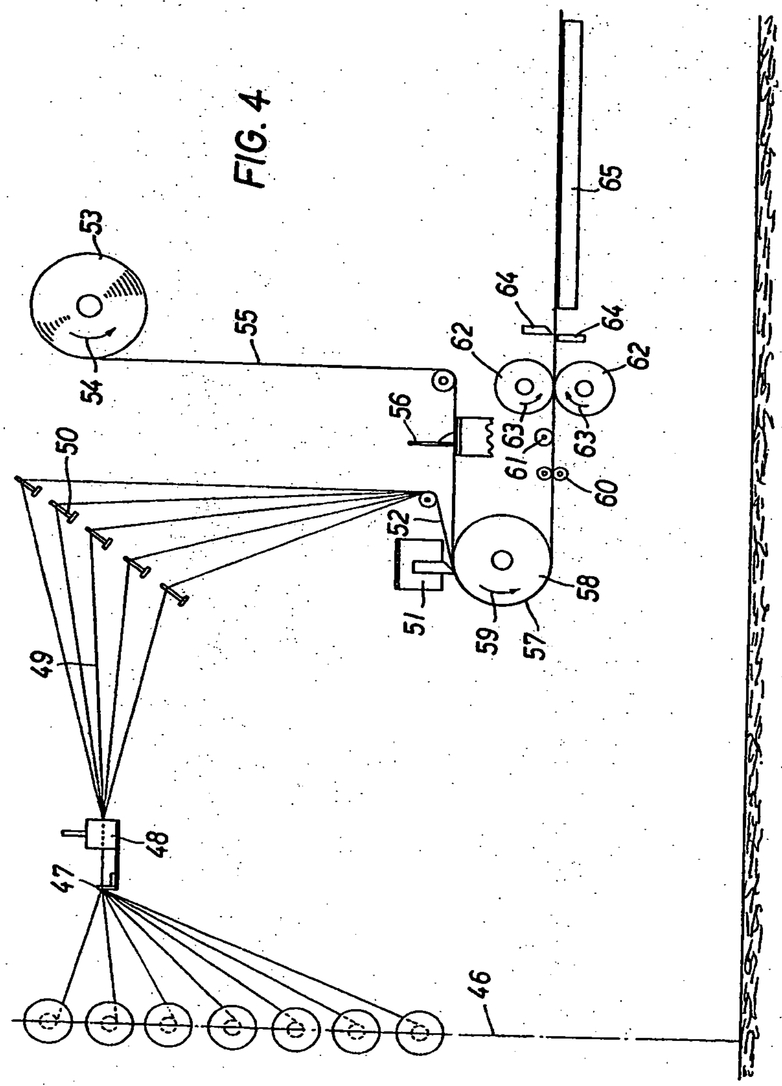

FIG. 4

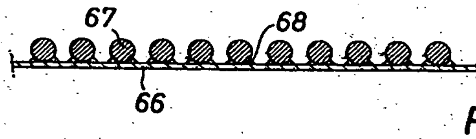

FIG. 5

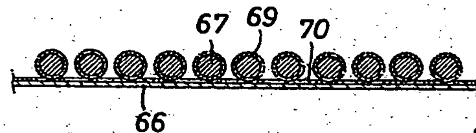

FIG. 6

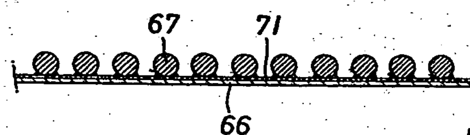

FIG. 7

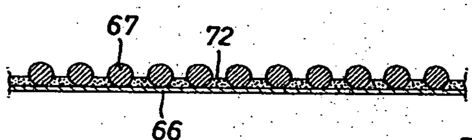

FIG. 8

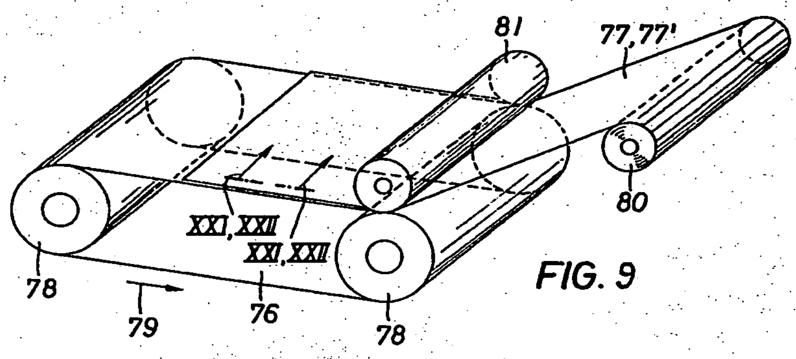

FIG. 9

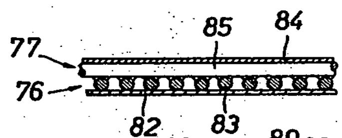

FIG.10

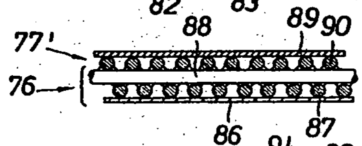

FIG.11

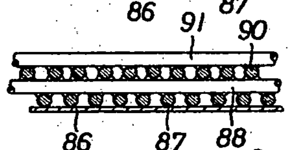

FIG.12

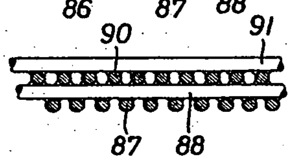

FIG.13